

ETMOPTERUS ROBINSI
(ELASMOBRANCHII, ETMOPTERIDAE), A NEW SPECIES OF
DEEPWATER LANTERN SHARK FROM THE CARIBBEAN SEA
AND WESTERN NORTH ATLANTIC, WITH A
REDESCRIPTION OF *ETMOPTERUS HILLIANUS*

Pamela J. Schofield and George H. Burgess

ABSTRACT

A new species of lantern shark, *Etmopterus robbinsi*, is described from the Caribbean Sea and western North Atlantic Ocean. Morphologically similar to and traditionally confused with *E. hillianus* (Poey, 1861), *E. robbinsi* is distinguished by differences in the shape of the supra-pelvic photophore pattern, the density and shape of dermal denticles, and the number of precaudal vertebral centra. It also reaches a greater maximum length and males achieve sexual maturity at a larger size than *E. hillianus*. The two species occupy similar geographic ranges, with *E. robbinsi* generally occupying depths greater than 300 fms and *E. hillianus* usually found in shallower waters at depths of less than 350 fms.

Luminescent photophores are present in many deepwater marine species, and their arrangement is often critical in species identification. Most lantern sharks of the genus *Etmopterus* (Etmopteridae, sensu Shirai, 1992) possess discrete patterns of photophores on their supra-pelvic lateral flanks, post-pelvic ventrum, and upper caudal fins. cursory examination of material believed to be *Etmopterus hillianus* (Poey 1861) taken from the western North Atlantic Ocean revealed the existence of two distinct photophore patterns in the otherwise morphologically similar specimens. Further studies revealed that additional characters also differ, resulting in the description of a new species, *Etmopterus robbinsi*.

We take great pleasure in naming this shark after C. Richard Robins in recognition of his many years of service to systematic ichthyology and his development of the important University of Miami ichthyological collection.

MATERIALS AND METHODS

All measurements were made on a projection and follow Springer (1979) and Springer and Burgess (1985). Proportions are expressed as percentages of pre-caudal length (PCL), total length (TL) or head length (HL: snout to pectoral origin). Institutional acronyms follow Leviton, et al. (1985). Specimens were radiographed to make precaudal vertebral centra counts. Prior to being radiographed, a metal pin was inserted dorsally through the caudal peduncle at the origin of the caudal fin of each specimen. Only vertebral centra located anterior to this pin on the radiograph were counted; the vertebral centrum touched by the pin was not counted. The vertebral centrum that abuts the neurocranium and is generally smaller (about one half the size) than other vertebral centra was included in the counts.

Etmopterus robbinsi new species

Figure 1, Table 1

Holotype.—UF 213167 (300 mm TL, male) R/V GERDA sta. 190, Northwest Providence Channel, Bahamas, 25°57'N, 78°07'W, 330–410 fms, 4 July 1963.

Paratypes (19 males, 24 females).—USNM 220287 (264 mm TL male), R/V OREGON sta. 3560, off Serranilla Bank, 16°35'N, 80°10'W, 315 fm, 18 May 1962; MCZ 40357 (261 mm TL male), R/V SILVER BAY sta. 452, off NE Florida, 29°54'N, 79°02'W, 430 fm, 11 June 1958; MCZ 40412 (4 females, 119–232 mm TL; 157 mm TL male), R/V SILVER BAY sta. 442, N of Little Bahama Bank, 27°53'N, 79°09'W, 375 fm, 9 June 1958; UF 27960 (252 mm TL male), R/V OREGON II sta. 11221, off Caribbean Nicaragua, 14°56'N 81°10'W, 300 fm, 26 Oct. 1970; UF 234673 (320 mm TL female; 310 mm TL

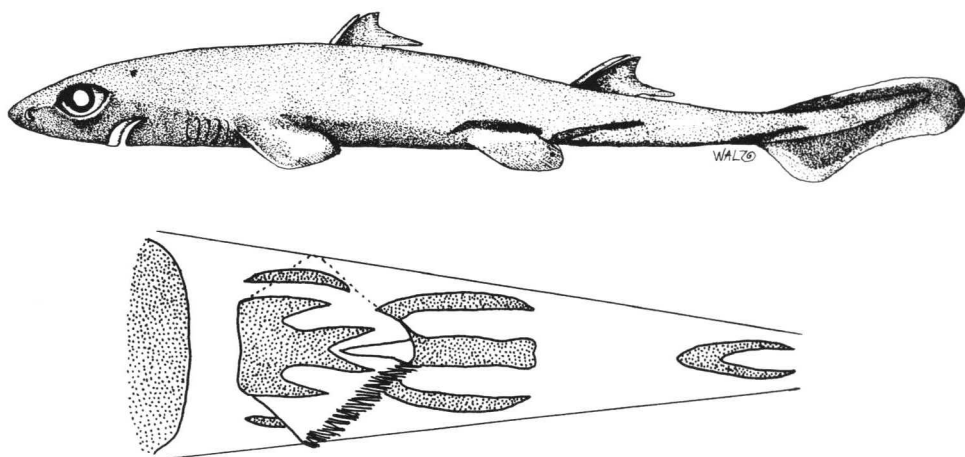


Figure 1. A (upper) *Etmopterus robinsi*, n.sp., lateral view B (lower) Supra-pelvic, post-pelvic and caudal photophore patterns of *E. robinsi*.

male), taken with holotype, R/V GERDA sta. 190, Northwest Providence Channel, Bahamas, 25°57'N, 78°07'W, 330–410 fm, 4 July 1963; USNM 220257 (2 females, 165–171 mm TL), R/V SILVER BAY sta. 5142, N of Hispaniola, 19°52'N, 71°58.5'W, 350 fm, 12 Oct. 1963; USNM 342072 (210 mm TL female; 3 males, 235–301 mm TL), R/V OREGON sta. 6721, Leeward Islands, 17°37.5'N, 62°48'W, 340–380 fm, 5 June 1967; USNM 220280 (295 mm TL male), R/V OREGON II sta. 10844, Leeward Islands, 17°24'N, 62°28'W, 344 fm, 8 Dec. 1969; USNM 220288 (260 mm TL male), R/V OREGON sta. 1927, SW of Isla de Providencia, 13°07'N, 82°08'W, 300 fm, 13 Sept. 1957; USNM 220291 (335 mm TL female), R/V OREGON II sta. 10847, Leeward Islands, 18°18'N, 63°24'W, 360 fm, 10 Dec. 1969; USNM 342073 (4 females, 170–245 mm TL), R/V OREGON II sta. 10842, Leeward Islands, 17°15'N, 62°22'W, 317 fm, 8 Dec. 1969; USNM 220300 (314 mm TL female, 166 mm TL male), R/V OREGON II sta. 10845, Leeward Islands, 17°33'N, 62°46'W, 365 fm, 9 Dec. 1969; UF 101904 (2 females, 275–295 mm TL; 285 mm TL male), R/V OREGON II sta. 10835, Leeward Islands, 18°28'N, 63°23'W, 373 fm, 6 Dec. 1969; USNM 220304 (275 mm TL female), R/V OREGON sta. 6722, Leeward

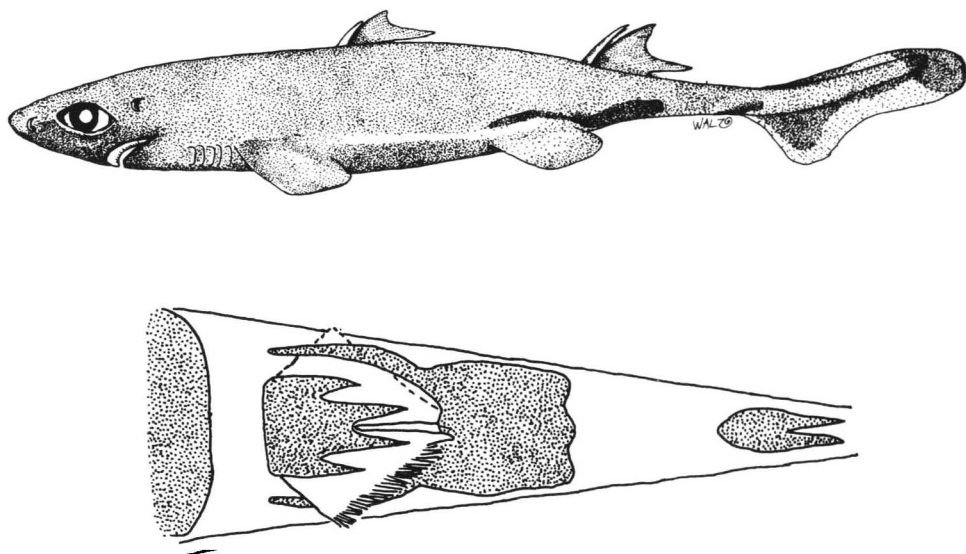


Figure 2. A (upper) *Etmopterus hillianus*, lateral view B (lower) Supra-pelvic, post-pelvic and caudal photophore patterns of *E. hillianus*.

Table 1. Proportional morphometrics of *E. robinasi* n.sp. Proportions are of: total length (TL), precaudal length (PCL), or head length (HL). Means are listed with corresponding ranges given in parentheses.

	Holotype 300	Males 157-301 16	Females 119-335 18	All 119-335 34
Total length (mm): N =				
Tip of snout to:				
anterior end nasal aperture (HL)	4.8	6.7 (4.8-8.7)	7.6 (3.3-12.3)	7.2 (3.3-12.3)
posterior end nasal aperture (HL)	8.9	11.5 (8.9-14.3)	11.8 (4.9-17.0)	11.7 (4.9-17.0)
front of mouth (HL)	41.4	41.4 (32.9-46.0)	45.2 (40.3-55.2)	43.4 (32.9-55.2)
eye (HL)	21.5	22.2 (20.9-24.8)	24.7 (21.5-31.0)	23.6 (20.9-31.0)
spiracle (HL)	50.0	55.0 (49.9-58.0)	57.4 (46.2-65.5)	56.3 (46.2-65.5)
first gill opening (HL)	81.5	79.3 (68.2-84.2)	82.7 (75.0-89.7)	81.1 (68.2-89.7)
origin pectoral fin (PCL)	28.7	28.2 (25.7-30.7)	21.6 (20.3-22.8)	24.7 (20.3-30.7)
origin first dorsal fin (PCL)	41.0	42.1 (39.1-45.0)	33.5 (31.7-35.7)	37.5 (31.7-45.0)
origin pelvic fin (PCL)	60.3	63.1 (60.3-65.1)	49.0 (45.4-58.2)	55.6 (45.4-65.1)
origin second dorsal fin (PCL)	72.6	73.4 (71.7-76.0)	56.8 (52.1-60.2)	65.1 (52.1-76.0)
origin caudal fin (TL)	78.0	77.5 (75.2-78.9)	76.9 (70.2-80.0)	77.3 (70.2-80.0)
cloaca (PCL)	65.0	67.4 (65.0-69.8)	67.8 (62.7-71.7)	67.7 (62.7-71.7)
Internasal distance (PCL)	26.5	24.4 (20.2-28.1)	23.5 (19.0-26.7)	23.9 (19.0-28.1)
Orbit length (HL)	13.7	13.6 (3.3-16.1)	13.7 (8.7-16.9)	13.7 (3.3-16.9)
Orbit height (HL)	23.5	22.1 (18.3-28.6)	25.4 (21.5-33.8)	23.9 (18.3-33.8)
Mouth width (HL)	8.6	10.3 (8.6-12.7)	12.4 (8.8-17.2)	11.4 (8.6-17.2)
Mouth length (HL)	32.3	32.8 (23.8-36.1)	33.6 (26.4-42.0)	33.2 (23.8-42.0)
Spiracle greatest diameter (HL)	6.6	6.7 (4.7-15.2)	9.0 (5.5-18.9)	7.9 (4.7-18.9)
Distance eye to spiracle (HL)	6.6	5.0 (3.7-7.2)	4.8 (3.4-6.9)	4.9 (3.4-7.2)
Height first gill slit (HL)	8.6	11.0 (8.6-13.0)	10.7 (7.9-12.4)	10.8 (7.9-13.0)
Height third gill slit (HL)	5.7	6.6 (4.7-10.4)	6.6 (4.4-9.4)	6.6 (4.4-10.4)
Height fifth gill slit (HL)	5.7	5.4 (4.2-7.0)	5.1 (2.9-7.2)	5.2 (2.9-7.2)
First dorsal (PCL):	5.7	5.6 (3.9-8.9)	5.2 (2.5-9.2)	5.4 (2.5-9.2)
length of base	5.2	5.6 (4.7-7.3)	5.7 (5.1-6.3)	5.7 (4.7-7.3)
length free inner margin	5.0	4.7 (2.3-5.7)	5.0 (3.7-5.9)	4.9 (2.3-5.9)
height	3.1	2.9 (2.2-3.4)	3.1 (2.2-4.2)	3.0 (2.2-4.2)
length anterior margin	2.4	3.1 (2.3-6.9)	3.8 (2.2-8.4)	3.5 (2.2-8.4)
length exposed portion of spine	2.9	3.7 (2.5-7.8)	3.4 (2.4-4.7)	3.5 (2.4-7.8)
Second dorsal (PCL):				
length of base	8.3	8.3 (4.9-10.8)	8.8 (7.1-9.9)	8.6 (4.9-10.8)

Table 1. Continued

	Total length (mm): N =	Holotype 300	Males 157-301 16	Females 119-335 18	All 119-335 34
length free inner margin height		7.4	6.3 (3.9-8.1)	6.9 (5.5-8.9)	6.6 (3.9-8.9)
length anterior margin		6.1	5.7 (3.9-7.7)	6.3 (4.3-11.3)	6.0 (3.9-11.3)
length exposed portion of spine		5.0	5.6 (3.1-10.2)	6.9 (4.5-12.0)	6.3 (3.1-12.0)
		broken	6.9 (5.9-9.5)	7.2 (4.8-8.9)	7.1 (4.8-9.5)
Pectoral fin (PCL):					
width of base		6.6	6.6 (5.9-8.1)	6.9 (5.9-8.1)	6.7 (5.9-8.1)
anterior margin		10.4	10.2 (6.2-11.9)	11.1 (9.4-13.0)	10.7 (6.2-13.0)
greatest width		7.8	8.0 (5.5-9.6)	7.7 (5.2-9.4)	7.8 (5.2-9.6)
Pelvic fin (PCL):					
overall length		12.9	12.3 (10.5-14.1)	12.8 (10.7-21.8)	12.6 (10.5-21.8)
anterior margin		5.1	4.8 (3.5-6.3)	5.2 (3.7-6.9)	5.0 (3.5-6.9)
distal margin		10.2	8.1 (6.8-10.2)	8.0 (4.0-10.4)	8.0 (4.0-10.4)
Tip 2nd dorsal to origin caudal (PCL):		11.2	10.9 (8.2-13.3)	10.1 (7.5-12.6)	10.5 (7.5-13.3)
Caudal upper margin (PCL):		27.0	21.1 (18.8-22.9)	21.1 (11.5-25.4)	21.1 (11.5-25.4)
Caudal lower lobe ant. margin (PCL):		10.8	8.7 (5.2-10.8)	9.4 (7.2-11.4)	9.1 (5.2-11.4)
Distance between fin bases (PCL):					
second dorsal to caudal		18.5	17.9 (16.2-19.6)	17.5 (15.8-18.8)	17.7 (15.8-19.6)
pectoral to pelvic		25.4	27.4 (24.0-30.1)	27.7 (25.1-30.4)	27.6 (24.0-30.4)
pelvic to caudal		26.8	27.4 (25.6-30.7)	25.2 (21.5-31.1)	26.2 (21.5-31.1)
Origin caudal to (PCL):					
tip of pectoral fin		22.7	21.3 (17.0-24.9)	19.9 (16.9-23.7)	20.5 (16.9-24.9)
1st dorsal spine		57.5	54.3 (50.1-57.5)	53.0 (50.2-56.5)	53.6 (50.1-57.5)
2nd dorsal spine		23.7	22.5 (20.4-24.2)	22.1 (19.5-23.8)	22.2 (19.5-24.3)
Clasper measurements (PCL):					
outer margin		2.4	1.9 (0.7-3.5)		1.9 (0.7-3.5)
inner margin		8.8	7.7 (3.8-14.6)		7.7 (3.8-14.6)
reach beyond pelvic fin		0.9	-0.1 (-2.3-1.3)		-0.1 (-2.3-1.3)

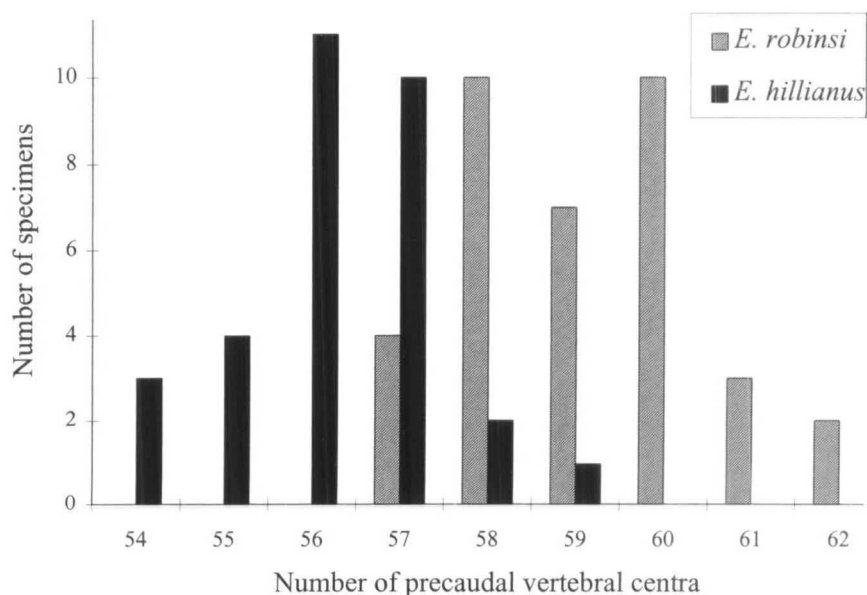


Figure 3. Number of precaudal vertebral centra in *Etmopterus robinsi* (N = 36) and *E. hillianus* (N = 31). The mean number of precaudal vertebral centra is 59.2 for *E. hillianus* and 56.2 for *E. robinsi*.

Islands, 17°34'N, 62°42'W, 382 fm, 5 June, 1967; UF 101905 (N=2) and USNM 220317 (N=1) (3 females, 224–254 mm TL), R/V SILVER BAY sta. 5142, N of Hispaniola, 19°52'N, 71°58.5'W, 350 fm, 10 Dec. 1963; USNM 220323 (294 mm TL male), R/V OREGON II sta. 10844, Leeward Islands, 17°24'N, 62°28'W, 344 fm, 8 Dec. 1969; USNM 220463 (170 mm TL female, 234 mm TL male), R/V OREGON II sta. 10843, Leeward Islands, 17°06'N, 62°17'W, 322 fm, 8 Dec. 1969; USNM 220293 (288 mm TL male), R/V OREGON sta. 4550, Straits of Florida W of Dry Tortugas, 24°25'N, 83°23'W, 225 fm, 27 Nov. 1963; UF 231349 (226 mm TL female), R/V GERDA sta. 1312, Northwest Providence Channel, Bahamas, 26°38.5'N 79°2.5'W, 276–288 fm, 31 March, 1971; UF 103144 (320 mm TL female), R/V GILLISS, Greater Antilles, exact location not available at time of publication; UF 103145 (338 mm TL female, 295–310 mm TL, 2 males), R/V GILLISS, Greater Antilles, exact location not available at time of publication.

Diagnosis.—*E. robinsi* is a small (maximum length of specimens examined is 338 mm TL for females and 310 mm TL for males), dark-colored shark bearing two dorsal spines and having upper teeth with five cusps and unicuspid lower teeth with recumbent cusps. Dermal denticles are needle-like and do not form rows. The ventral side of the snout is fully scaled. The interdorsal distance is approximately as long as the distance from snout tip to pectoral insertion. Supra-pelvic, post-pelvic and caudal photophore patterns are prominent.

E. robinsi traditionally has been confused with *E. hillianus*. However, *E. robinsi* can be distinguished from *E. hillianus* by the following characters:

SHAPE OF SUPRA-PELVIC PHOTOPHORE PATCH. The supra-pelvic photophore patterns for *E. robinsi* and *E. hillianus* are distinctive (Figs. 1, 2). The anterior branch of the patch is disjunct from the posterior branch in *E. robinsi* but the two are connected in *E. hillianus*. In *E. robinsi*, the pointed, finger-shaped posterior branch extends well past the rear base of the second dorsal fin (midway between that base and the free rear tip). By contrast, in *E. hillianus* it forms a blunt block that extends to just beyond the rear base of the second dorsal fin and broadly merges ventrally with the post-pelvic photophore patch.

NUMBER OF PRECAUDAL VERTEBRAL CENTRA. The number of precaudal vertebral centra for *E. robinsi* and *E. hillianus* varied (mean = 59.1, range 57–62, N = 36

for *E. robinsi*; mean = 56.2, range = 54–59, $N = 31$ for *E. hillianus*) and was statistically significant ($t = 9.28$, $df = 65$, $P < 0.05$; Fig. 3).

DENTICLES. The relative density of denticles per given surface area is approximately two to three times higher in *E. hillianus* than in *E. robinsi* (approximately 1,000 denticles per cm^2 for *E. robinsi*; 2,500 denticles per cm^2 for *E. hillianus*). Additionally, the denticles of *E. hillianus* are much longer and more recurved than the blunt, more erect denticles of *E. robinsi* (Figs. 4, 5).

In addition, the two species differ biologically and ecologically. *E. robinsi* reaches a larger maximum size (335 mm TL) than *E. hillianus* (278 mm TL), and males reach sexual maturity at a larger size (260 mm TL vs. 200 mm TL in *E. hillianus*). *E. robinsi* is generally found in depths greater than 300 fm, while *E. hillianus* is usually found in depths less than 350 fm (Fig. 6).

Description.—The head is large (snout tip to origin of pectoral fin about 25% PCL) and dorso-ventrally flattened. A depression exists dorsally just forward of the eyes. The rounded, somewhat triangular snout slopes outward from its tip to the anterior end of the nasal aperture. The snout continues to slope outward posteriorly from the anterior end of the nasal aperture to the anterior edge of the orbit opening. Nasal apertures are large (their diameter is approximately 15% of the head length) and consist of two openings separated by a thin bridge of tissue. The ventral nasal opening is the larger of the two and oblong in shape. The most anterior portion of this opening is the region of connection to the small, round anterior nasal opening. The orbit opening is quite long (about 25% of the head length) and consists of a narrow slit. Dorsal view of the head reveals concavity about the length of the orbit opening. The spiracle is oblong, more dorsal and just posterior to orbit. A dark, circular patch is present between and just posterior to the spiracles. The light colored mid-dorsal stripe with a fine black line or series of dashes or dots in its center extends posteriorly from this dark patch to the base of the caudal fin, interrupted only by the dorsal fins. Gill slits are small and decrease in height posteriorly. The last gill slit is situated at the origin of the pectoral fin. Mouth is broadly rounded, the corners aligning with the posterior end of the orbit opening. Tip of snout to front of mouth about 45% of head length. Narrow margin around mouth not covered in denticles, otherwise the rest of the head is densely denticled. The teeth in the upper jaw of *E. robinsi* have five cusps, and the lower jaw contains unicuspid teeth with recumbent cusps.

Pectoral fin is triangular, its anterior margin smooth and distal margin moderately frayed. Anterior margin is almost twice the length of the base. When pressed against the body, the tip of the pectoral fin is just anterior to the origin of the first dorsal fin. The first dorsal fin is small (its height only approximately 3% of PCL), its anterior margin smooth and distal margin moderately frayed. The free inner margin of the first dorsal fin is just less than the length of its base. First dorsal spine small, shorter than the height of the fin. Tip of free inner margin of first dorsal fin well anterior to pelvic fin origin. Pelvic fins are of medium size, the smooth anterior margin about $\frac{3}{4}$ times as long as the moderately frayed distal margin. Clasper outer margin about $\frac{1}{4}$ as long as the inner margin in mature specimens. Clasper tips located just before pelvic fin tips in small specimens and expand with growth to just beyond fin tips. The second dorsal origin is anterior to pelvic fin tips. Second dorsal fin spine is large, recurved, and with a triangular base. Fin spine slightly taller than fleshy portion of fin. Free inner margin and height of second dorsal almost equal, both less than the length of the base. Distance from the base of the second dorsal to the caudal fin about 75% of the interdorsal distance. Anterior margin of lower lobe of caudal fin about 40% that

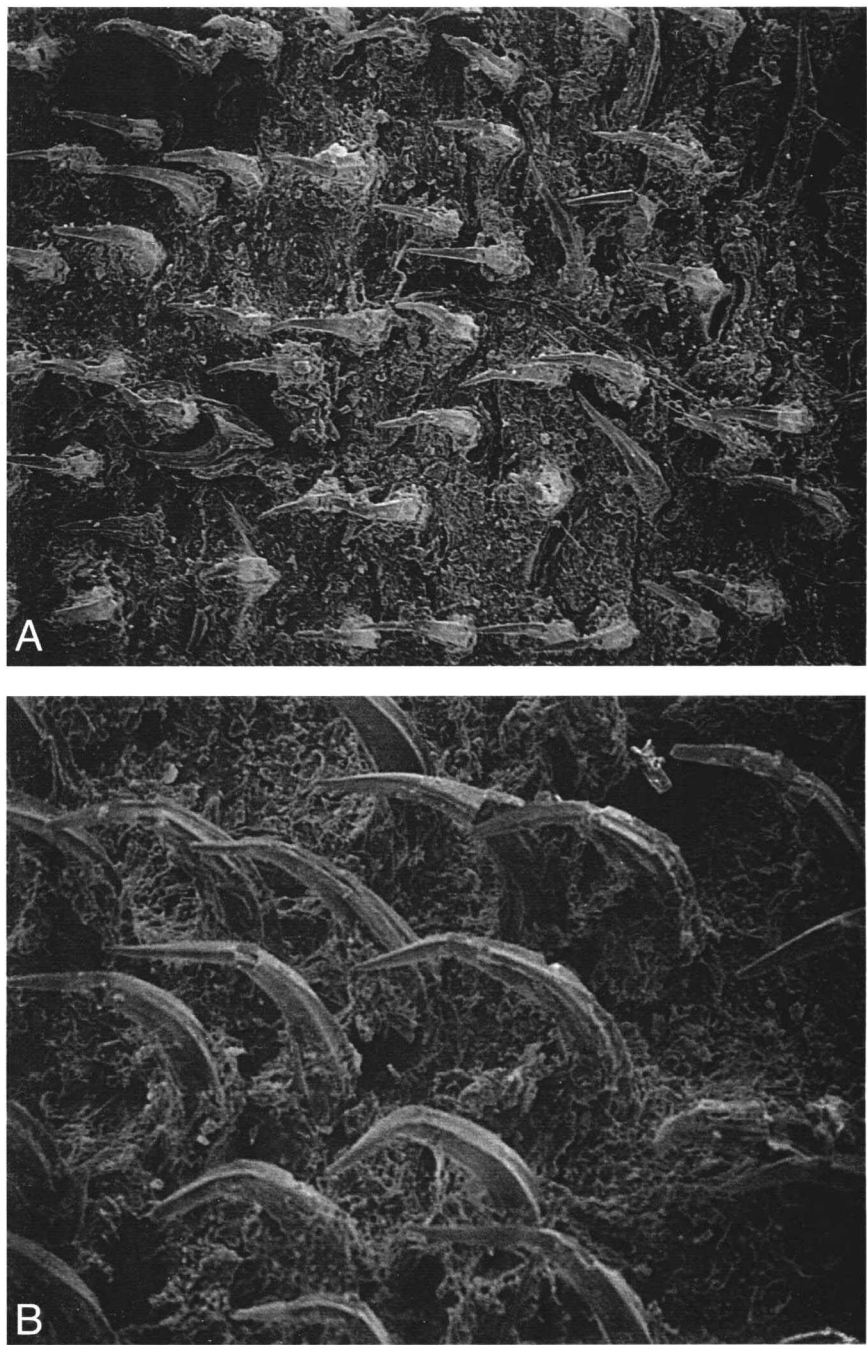


Figure 4. Scanning electron micrograph of the dermal denticles of *Etmopterus robbinsi* taken from just below the second dorsal fin photographed at angles of (A upper) 90° (50×) and (B lower) 45° (100×).

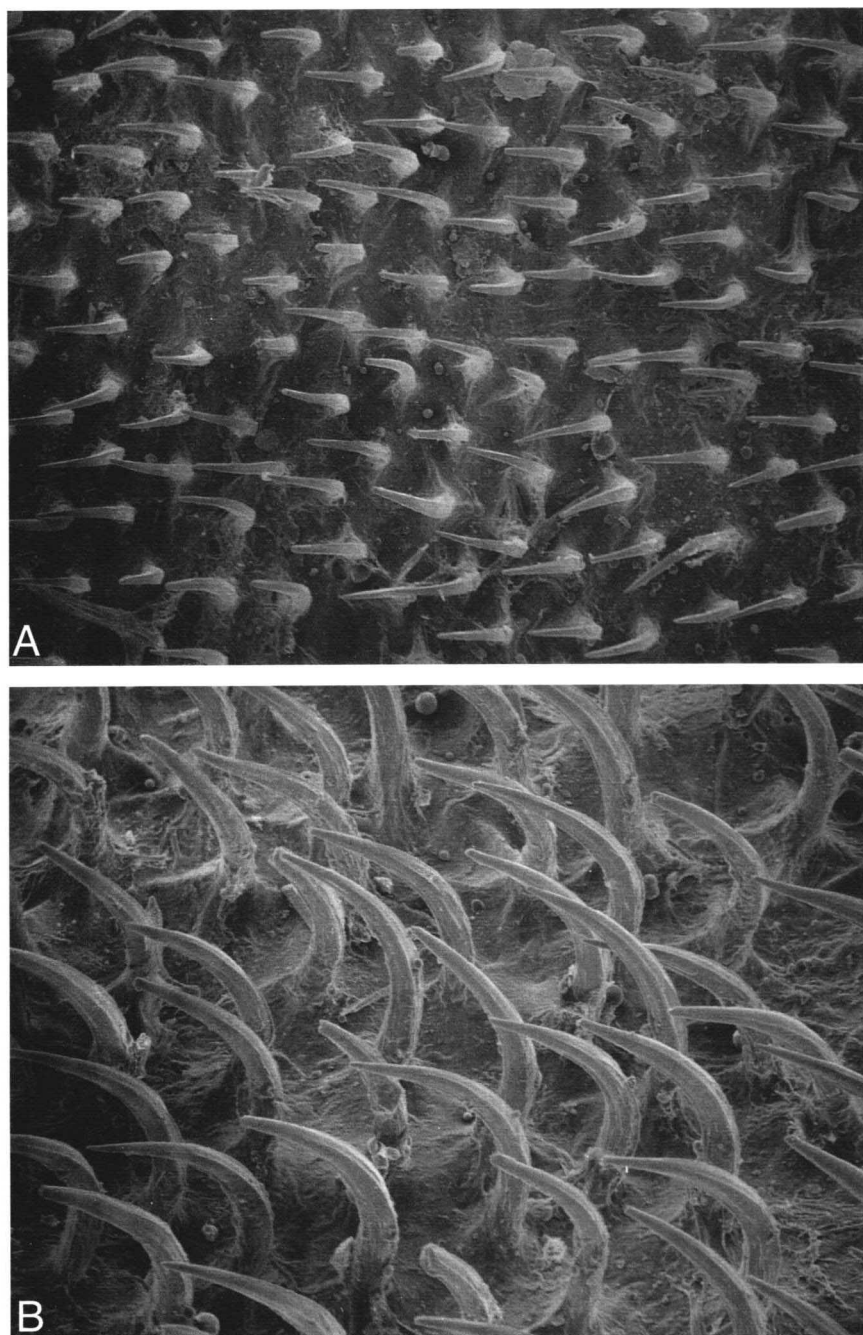


Figure 5. Scanning electron micrograph of the dermal denticles of *Etmopterus hillianus* taken from just below the second dorsal fin photographed at angles of (A upper) 90° (50 \times) and (B lower) 45° (100 \times).

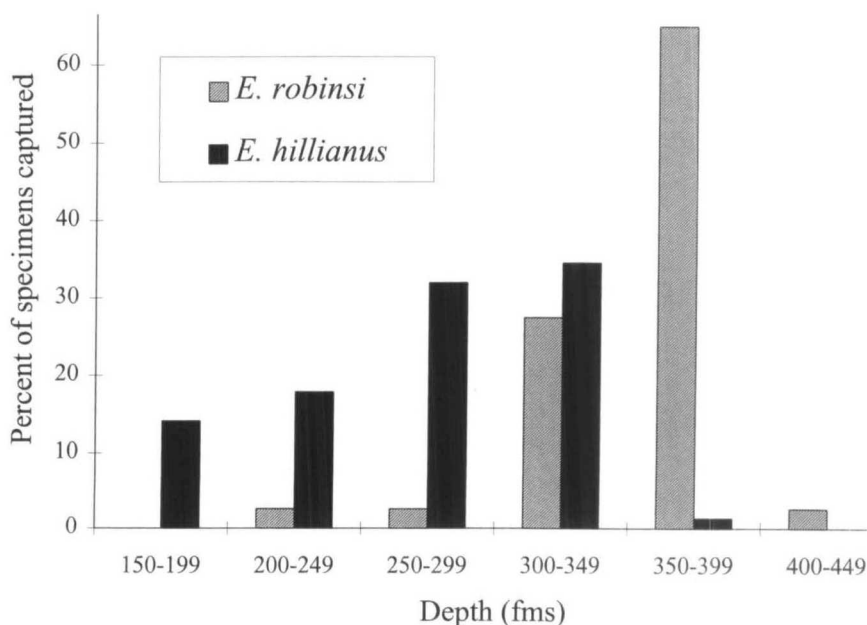


Figure 6. Frequency of capture of *Etmopterus robinsi* and *E. hillianus* as a function of depth. The mean depth of capture is 348 fms (range: 225–430 fms) for *E. robinsi* and 263 (range: 170–380 fms) for *E. hillianus*. Totals of 118 locality records, 40 for *E. robinsi* and 78 for *E. hillianus*, were used to construct this figure.

of upper lobe. Distance from pelvic to pectoral fin bases slightly greater or equal to the distance from pelvic to origin of lower lobe of caudal fin.

Using radiographs, the number of precaudal vertebral centra in 36 specimens ranged from 57 to 62 (mean = 59.1). The holotype (UF 213167) has 60 precaudal vertebral centra.

The needlelike denticles of *E. robinsi* are blunt and much less recurved than those of *E. hillianus*. Density estimates from scanning electron micrographs indicate that approximately 1,000 denticles per cm² of skin are present on the flank of *E. robinsi*. Values slightly lower than this figure were found for skin samples taken from just below the first dorsal fin and values slightly greater were found for skin samples taken from just below the second dorsal fin. Denticles found in the supra-pelvic photophore patch were approximately as dense as those sampled from below the second dorsal fin.

The supra-pelvic photophore pattern of *E. robinsi* consists of a thin, anterior branch extending anteriorly to the pelvic fin origin, where it ends in a pointed tip; and a long, thin finger-like posterior branch ending with a pointed tip extending well past the rear base of the second dorsal to about halfway to the free rear tip. The two branches are separated by a break in continuity just anterior to the supra-pelvic base, which connects the lateral supra-pelvic patch with the ventral post-pelvic photophore patch. The supra-pelvic base is short and very thin. The post-pelvic photophore pattern extends posteriorly as a narrow band mid-ventrally to about the level of the posterior extension of the supra-pelvic pattern. A similar-sized band darkened by melanophores connects the post-pelvic and caudal photophore patterns. The finger-like lateral extensions of the caudal photophore patch are narrow and pointed.

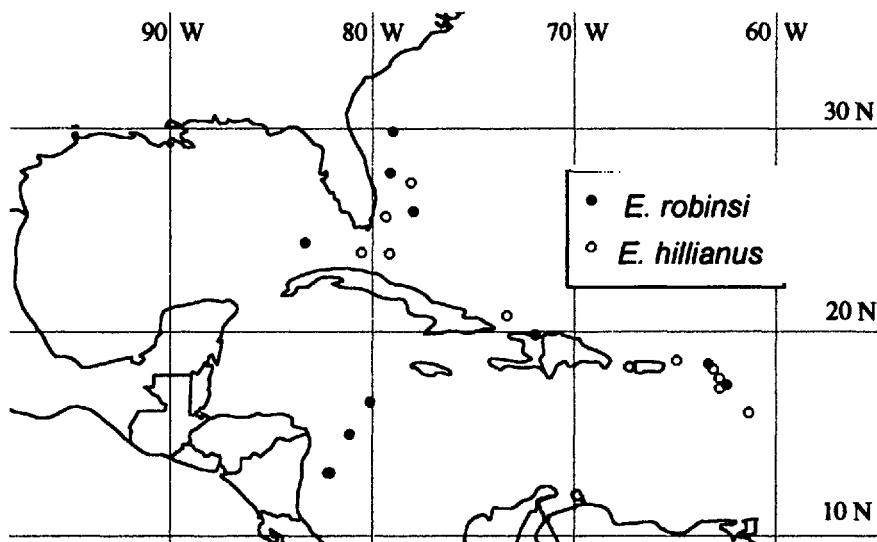


Figure 7. Geographic distribution of *Etmopterus robinsi* and *Etmopterus hillianus*. Single dots may represent multiple collections from proximate localities.

Maximum lengths of specimens examined were 335 mm TL (female) and 310 mm TL (male). Based on maturity of male claspers, the smallest mature male *E. robinsi* examined was 260 mm TL.

Geographic Range.—*E. robinsi* ranges from off northeastern Florida and the Straits of Florida south to the offings of Nicaragua, Hispaniola and the northern Lesser Antilles (Fig. 7). It has not been collected in the southern Caribbean Sea and only in the southern-most Gulf of Mexico. *E. robinsi* has been taken in 225–430 fm (411.5–786.3 m), with all but two specimens (5% of specimens) collected from greater than 300 fm (548.6 m) (Fig. 6).

Etmopterus hillianus (Poey 1861)

Figure 2, Table 2

Holotype.—MCZ 1025, 269 mm TL female (?), from Cuba. The holotype of *E. hillianus* is in extremely poor condition (all fins and snout damaged, teeth missing, almost all skin and denticles lost). The body of the holotype, however, is intact and was radiographed to make a precaudal vertebral centra count.

Diagnosis.—See diagnosis for *E. robinsi* above.

Description.—*E. hillianus* has a dorso-ventrally flattened, rather large head (snout tip to pectoral fin origin about 30% PCL). A depression exists dorsally just forward of the eyes. The snout has a triangular tip and slopes outward from its tip to the anterior end of the nasal aperture. The snout continues to slope outward posteriorly from the anterior end of the nasal aperture to the anterior edge of the orbit opening. Nasal apertures are large (their diameter approximately 15% of head length) and consist of two openings separated by a thin bridge of tissue. The ventral nasal opening is the larger of the two and oblong in shape. The most anterior portion of this opening is the region of connection to the small, round anterior nasal opening. The orbit opening consists of a narrow slit that is quite long (about 25% of the head length). The orbit opening is concave when viewed dorsally. The spiracle is oblong, more dorsal and just posterior to orbit. A dark,

Table 2. Proportional morphometrics of *Etmopterus hillianus*. Proportions are of: total length (TL), precaudal length (PCL), or head length (HL). Means are listed with corresponding ranges given in parentheses.

Total length (mm): N =	Males 165–255 20	Females 105–278 20	All 105–278 40
Tip of snout to:			
anterior end nasal aperture (HL)	7.6 (4.7–12.2)	8.4 (4.1–12.8)	8.0 (4.1–12.8)
posterior end nasal aperture (HL)	12.4 (9.3–18.4)	14.0 (8.6–18.2)	13.2 (8.6–18.4)
front of mouth (HL)	44.1 (39.6–55.3)	44.6 (36.7–54.5)	44.4 (36.7–55.3)
eye (HL)	23.9 (17.6–36.8)	23.9 (19.2–30.8)	23.9 (17.6–36.8)
spiracle (HL)	54.6 (49.1–62.1)	56.8 (51.2–64.8)	55.6 (49.1–64.8)
first gill opening (HL)	79.9 (70.7–92.8)	78.7 (72.3–87.9)	79.3 (70.7–92.8)
origin pectoral fin (PCL)	28.5 (24.0–32.5)	29.4 (25.5–32.7)	29.0 (24.0–32.7)
origin first dorsal fin (PCL)	42.6 (39.8–45.9)	42.7 (35.2–46.6)	42.6 (35.2–16.6)
origin pelvic fin (PCL)	61.4 (57.3–64.8)	61.7 (51.2–65.7)	61.6 (51.2–65.7)
origin second dorsal fin (PCL)	72.9 (70.6–75.3)	73.3 (64–78.9)	73.1 (64.0–78.9)
origin caudal fin (TL)	77.0 (72.5–80.3)	76.6 (70.6–79.3)	76.8 (70.6–80.3)
cloaca (PCL)	66.6 (60.5–71.8)	67.2 (62.4–72.2)	66.9 (60.5–72.2)
Interdorsal distance (PCL)	24.4 (21.1–29.9)	25.1 (21.4–30.4)	24.7 (21.1–30.4)
Internasal distance (HL)	14.4 (11.8–21.1)	13.6 (11.1–17.9)	14.0 (11.1–21.1)
Orbit length (HL)	22.0 (17.8–29.3)	23.6 (14.9–33.3)	22.8 (14.9–33.3)
Orbit height (HL)	9.5 (7.9–11.8)	9.2 (7.0–12.1)	9.3 (7.0–12.1)
Mouth width (HL)	35.3 (30.1–47.4)	35.3 (29.3–39.4)	35.3 (29.3–47.4)
Mouth length (HL)	8.3 (2.7–14.9)	9.1 (4.8–17.9)	8.7 (2.7–17.9)
Spiracle greatest diameter (HL)	5.4 (3.9–9.3)	5.3 (3.2–8.6)	5.3 (3.2–9.3)
Distance eye to spiracle (HL)	11.2 (8.1–18.4)	11.7 (8.2–17.1)	11.4 (8.1–18.4)
Height first gill slit (HL)	7.1 (3–12.2)	8.2 (5.1–12.8)	7.6 (4.3–12.8)
Height third gill slit (HL)	5.6 (3.8–8.6)	5.5 (3.2–8.0)	5.5 (3.2–8.6)
Height fifth gill slit (HL)	6.6 (3.8–10.5)	7.0 (4.1–12.1)	6.8 (3.8–12.1)
First dorsal (PCL):			
length of base	4.8 (2.2–6.2)	5.9 (4.6–8.8)	5.3 (4.7–7.3)
length free inner margin	5.3 (3.0–6.3)	4.9 (2.2–6.3)	5.1 (2.2–6.3)
height	3.7 (2.7–6.3)	4.2 (2.1–5.6)	3.9 (2.1–6.3)
length anterior margin	4.7 (2.6–8.4)	6.6 (2.1–11.2)	5.6 (2.1–11.2)
length exposed portion of spine	2.8 (2.1–3.8)	3.1 (2.3–5.3)	2.9 (2.1–5.3)
Second dorsal (PCL):			
length of base	8.8 (7.2–9.8)	8.9 (6.0–12.0)	8.8 (6.0–12.0)
length free inner margin	6.7 (4.9–8.5)	7.4 (5.6–10.3)	7.0 (4.9–10.3)
height	7.0 (5.3–9.8)	8.2 (5.0–13.6)	7.6 (5.0–13.6)
length anterior margin	8.7 (6.0–13.4)	9.9 (5.4–14.9)	9.3 (5.4–14.9)
length exposed portion of spine	7.5 (5.8–8.6)	8.7 (6.9–10.6)	8.0 (5.8–10.6)
Pectoral fin (PCL):			
width of base	6.3 (5.2–9.0)	6.4 (5.4–8.0)	6.4 (5.2–9.0)
anterior margin	11.1 (8.6–15.3)	12.0 (7.9–18.4)	11.6 (7.9–18.4)
greatest width	8.1 (6.6–10.8)	9.3 (6.0–15.3)	8.7 (6.0–15.3)
Pelvic fin (PCL):			
overall length	12.9 (11.5–16.1)	14.0 (11.9–19.2)	13.4 (11.5–19.2)
anterior margin	5.5 (1.8–7.5)	6.1 (4.2–8.7)	5.8 (1.8–8.7)
distal margin	7.8 (3.3–9.8)	8.6 (6.7–9.7)	8.1 (3.3–9.8)
Tip 2nd dorsal to origin caudal (PCL):	11.0 (7.7–13.4)	10.7 (8.0–16.0)	10.9 (7.7–16.0)
Caudal upper margin (PCL):	21.8 (18.3–24.4)	22.6 (18.7–27.9)	22.2 (18.3–27.9)
Caudal lower lobe ant. margin (PCL):	8.7 (7.0–11.2)	8.6 (6.8–10.2)	8.6 (6.8–11.2)
Distance between fin bases (PCL):			
second dorsal to caudal	18.1 (14.7–20.7)	17.4 (15.5–20.8)	17.8 (14.7–20.8)
pectoral to pelvic	25.8 (22.5–29.7)	26.7 (18.8–31.0)	26.2 (22.2–29.5)
pelvic to caudal	27.5 (23.8–29.5)	25.3 (22.2–27.9)	26.5 (22.2–29.5)

Table 2. Continued

Total length (mm): N =	Males 165–255 20	Females 105–278 20	All 105–278 40
Origin caudal to (PCL):			
tip of pectoral fin	20.9 (16.0–25.2)	21.2 (17.3–28.0)	21.0 (16.0–28.0)
1st dorsal spine	54.9 (51.7–60.0)	54.3 (52.0–57.8)	54.7 (51.7–60.0)
2nd dorsal spine	23.9 (20.4–27.5)	22.2 (19.9–25.4)	23.2 (19.9–27.5)
Clasper measurements (PCL):			
outer margin	2.4 (0.6–4.2)		2.4 (0.6–4.2)
inner margin	8.0 (5.9–9.8)		8.0 (5.9–9.8)
reach beyond pelvic fin (PCL):	0.2 (–1.9–1.9)		0.2 (–1.9–1.9)

circular patch is present between and just posterior to the spiracles. A light colored mid-dorsal stripe extends posteriorly from this dark patch, interrupted by dorsal fins, to the base of the caudal fin; a fine black line or series of dots or dashes is found in the center of the stripe. Gill slits are small and decrease in height posteriorly. The last gill slit is situated at the origin of the pectoral fin. Mouth is broadly rounded, the corners aligning with the posterior end of the orbit opening. Tip of snout to front of mouth about 45% of head length. Narrow margin around mouth not covered in denticles, otherwise the rest of the head is densely covered in denticles. The teeth in the upper jaw of *E. hillianus* have five cusps, and the lower jaw contains unicuspid teeth with recumbent cusps.

Pectoral fin triangular, its anterior margin smooth and distal margin moderately frayed. Anterior margin almost twice the length of the base. When pressed against the body, the tip of the pectoral fin is just anterior to the origin of the first dorsal fin. The first dorsal fin is small (its height only about 5% of PCL), its anterior margin smooth and distal margin moderately frayed. The free inner margin of the first dorsal fin is just less than the length of its base. The small first dorsal spine is shorter than the height of the fin. Tip of free inner margin of first dorsal fin well anterior to pelvic fin origin. Pelvic fins are of medium size, the smooth anterior margin about $\frac{3}{4}$ times as long as the moderately frayed distal margin. Clasper outer margin about $\frac{1}{4}$ as long as the inner margin in mature specimens. Clasper tips located just before pelvic fin tips in small specimens and expand with growth to just beyond fin tips. Second dorsal origin anterior to pelvic fin tips. Fin spine at second dorsal large, recurved, with a triangular base. Fin spine slightly taller than fleshy portion of fin. Free inner margin and height of second dorsal almost equal, both less than the length of the base. Distance from the base of the second dorsal to the caudal fin about 70% of the interdorsal distance. Anterior margin of lower lobe of caudal fin about 40% of caudal fin upper margin. Distance from pelvic to pectoral fin bases approximately equal to the distance from pelvic to lower caudal origin.

Based on radiographs, the number of precaudal vertebral centra in 31 specimens ranged from 54 to 59 (mean = 56.2). The holotype (MCZ 1025) has 54 precaudal vertebral centra.

The needlelike denticles of *E. hillianus* are long (about $1\frac{1}{2}$ times the length of denticles from *E. robinsoni*) and quite recurved. Density estimates from scanning electron micrographs reveal that approximately 2,500 denticles per cm² of skin are present on the flank of *E. hillianus*. Values slightly lower than this figure were found for skin samples taken from just below the first dorsal fin and slightly greater values were found for skin samples taken from just below the second

dorsal fin. Denticles found in the photophore pattern were more dense ($>3,400$ per cm^2) than the samples from below either of the dorsal fins.

The supra-pelvic photophore pattern of *E. hillianus* consists of connected anterior and posterior branches. The thin anterior branch extends anteriorly to the level of the pelvic fin origin, where it ends in a rounded tip. The broad and bluntly terminated posterior branch merges ventrally and throughout its length with the post-pelvic photophore patch. The posterior branch extends slightly past the rear base of the second dorsal fin, and extends so bluntly ventrally that a distinct supra-pelvic base is indistinguishable in most specimens. The post-pelvic photophore pattern extends posteriorly to the level of the posterior limits of the supra-pelvic photophore pattern. Lying between, but not connected to, the post-pelvic and caudal photophore patches is a squarish patch darkened by melanophores. The finger-like lateral extensions of the caudal photophore patch on the upper caudal lobe are somewhat broader than those of *E. robinisi*.

Maximum lengths of specimens examined are 278 mm TL (female) and 256 mm TL (male). Based on state of male clasper maturity, the smallest mature male *E. hillianus* examined was 200 mm TL.

Geographic Range.—*E. hillianus* is known from the Bahamas and southern Florida south to Cuba, Hispaniola and the northern Lesser Antilles (Fig. 7). It has not been taken in the western or southern Caribbean Sea. Depths of capture ranged from 170 to 380 fm (311–695 m), with 99% of the specimens taken in depths less than 350 fm (Fig. 6).

Specimens Measured (20 males, 20 females).—MCZ 41074 (199 mm TL female), R/V COMBAT sta. 446, Straits of Florida, $25^{\circ}10'N$, $79^{\circ}13'W$, 250 fm, 23 July 1957; UF 34956 (3 females, 150–254 mm TL), Virgin Islands, $18^{\circ}9'N$ $65^{\circ}10'W$, 172 fm, Nov/Dec 1981; UF 42187 (105 mm TL female, 175 mm TL male), R/V OREGON sta. 2606, Virgin Islands, $18^{\circ}37.5'N$, $64^{\circ}57'W$, 220 fm, 26 Sep. 1959; UF 42188 (165 mm TL male), R/V OREGON sta. 2651, N of Puerto Rico, $18^{\circ}16'N$, $67^{\circ}16.5'W$, 230 fm, 6 Oct. 1959; UF 213836 (226 mm TL male), Straits of Florida, R/V GERDA sta. 234, $25^{\circ}42'N$, $79^{\circ}23'W$, 247–259 fm, 30 Jan. 1964; UF 226464 (2 females, 226–270 mm TL; 240 mm TL male), R/V PILLSBURY sta. 936, Leeward Islands, $16^{\circ}02'N$, $61^{\circ}23'W$, 255–350 fm, 16 July 1969; UF 101906 (5 females, 247–278 mm TL; 5 males, 244–255 mm TL), R/V OREGON sta. 5926, Leeward Islands, $15^{\circ}36'N$, $61^{\circ}13'W$, 275 fm, 3 Nov. 1960; USNM 220274 (225 mm TL male), R/V OREGON sta. 6721, Leeward Islands, $17^{\circ}37.5'N$, $62^{\circ}48'W$, 340–380 fm, 5 June 1967; USNM 220294 (245 mm TL female), R/V OREGON II sta. 10842, Leeward Islands, $17^{\circ}15'N$, $62^{\circ}22'W$, 317 fm, 8 Dec. 1969; USNM 220295 (2 males, 165–176 mm TL), R/V OREGON sta. 5916, Leeward Islands, $18^{\circ}10'N$, $63^{\circ}16'W$, 185 fm, 25 Feb. 1966; USNM 220296 (6 females, 153–214 mm TL; 2 males, 80–189 mm TL), R/V SILVER BAY sta. 2468, Santaren Channel E of Cay Sal Bank, $23^{\circ}52'N$, $79^{\circ}11'W$, 210–200 fm, 6 Nov. 1960; USNM 220298 (3 males, 228–248 mm TL), R/V OREGON sta. 6695, Leeward Islands, $17^{\circ}41'N$, $62^{\circ}50.0'W$, 300–320 fm, 18 May 1967; USNM 220302 (182 mm TL female; 3 males, 202–212 mm TL), R/V SILVER BAY sta. 2449, Santaren Channel E of Cay Sal Bank, $23^{\circ}55'N$, $80^{\circ}34'W$, 270 fm, 3 Nov. 1960.

Additional Specimens Examined (26 males, 22 females).—MCZ 41074 (215 mm TL female; 2 males, 140 and 215 mm TL), R/V COMBAT sta. 446, Straits of Florida, $25^{\circ}10'N$, $79^{\circ}13'W$, 250 fm, 23 July 1957; UF 224402 (201 mm TL female), R/V GERDA sta. 1012, Nicholas Channel N of Cuba, $23^{\circ}35'N$, $79^{\circ}33'W$, 278–290 fm, 14 June 1968; USNM 220305 (245 mm TL female), Windward Passage off Great Inagua Island, $20^{\circ}50'N$, $73^{\circ}23'W$, 170 fm, 13 Dec. 1969; USNM 220316 (2 females, 199–245 mm TL), R/V OREGON sta. 6698, Leeward Islands, $17^{\circ}43'N$, $62^{\circ}49'W$, 205–216 fm, 19 May 1967; USNM 75050 (220 mm TL female), R/V ALBATROSS sta. 2655, N of Little Bahama Bank, $27^{\circ}22'N$, $78^{\circ}07.5'W$, 338 fm, 1886; USNM 220295 (5 females, 235–260 mm TL), R/V OREGON sta. 5916, Leeward Islands, $18^{\circ}10'N$, $63^{\circ}16'W$, 185 fm, 25 Feb. 1966; USNM 220301 (2 females, 217–234 mm TL; 5 males, 201–230 mm TL), R/V OREGON II sta. 10862, Santaren Channel E of Cay Sal Bank, $23^{\circ}25'N$, $79^{\circ}40'W$, 16 Dec. 1969; UF 77860 (4 females, 211–255 mm TL; 235 mm TL male), R/V OREGON II sta. 31723, N of Puerto Rico, $18^{\circ}18'N$, $67^{\circ}18'W$, 290 fm, 27 June 1980; USNM 220325 (5 females, 220–258 mm TL; 17 males, 225–256 mm TL), R/V OREGON sta. 6695, Leeward Islands, $17^{\circ}14'N$, $62^{\circ}50.2'W$, 300–320 fm, 19 May 1967; USNM 220296 (165 mm TL male), R/V SILVER BAY sta. 2468, Santaren Channel E of Cay Sal Bank, $23^{\circ}52'N$, $79^{\circ}11'W$, 210–200 fm, 6 Nov. 1960.

ACKNOWLEDGMENTS

We are grateful of Karsten Hartel's support during Burgess' visit to MCZ and his willingness to send us the holotype of *E. hillianus*. V. Springer, J. T. Williams, and S. Jewett are thanked for support and courtesies extended to Burgess while visiting the USNM. We also thank C. R. Robins for loan of UMML material and A. Mouat for translating Poey's original description of *E. hillianus*. L. Walz illustrated Figures 1a and 2a. N. Ansay graciously constructed Figure 7.

LITERATURE CITED

- Springer, S. 1979. A revision of the catsharks, family Scyliorhinidae. U. S. National Marine Fisheries Service, NOAA Tech. Rep. NMFS Circ. 422, 152 p.
- and G. H. Burgess. 1985. Two new dwarf dogsharks (*Etmopterus*, Squalidae), found off the Caribbean coast of Colombia. *Copeia* 1985: 584–591.
- Leviton, A. E., R. H. Gibbs, Jr., E. Heal and C. E. Dawson. 1985. Standards in herpetology and ichthyology: Part 1. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985: 802–832.
- Shirai, S. 1992. Squalan Phylogeny: A New Framework of "Squaloid" Sharks and Related Taxa. Hokkaido University Press, Sapporo, Japan. 151 p.

DATE ACCEPTED: January 27, 1997.

ADDRESSES: (P.J.S.), *Department of Zoology, University of Florida, Gainesville, FL 32611*. Current Address: *Department of Biological Sciences, University of Southern Mississippi, Hattiesburg, MS 39406*. (G.H.B.), *Florida Museum of Natural History, University of Florida, Gainesville, FL 32611*.